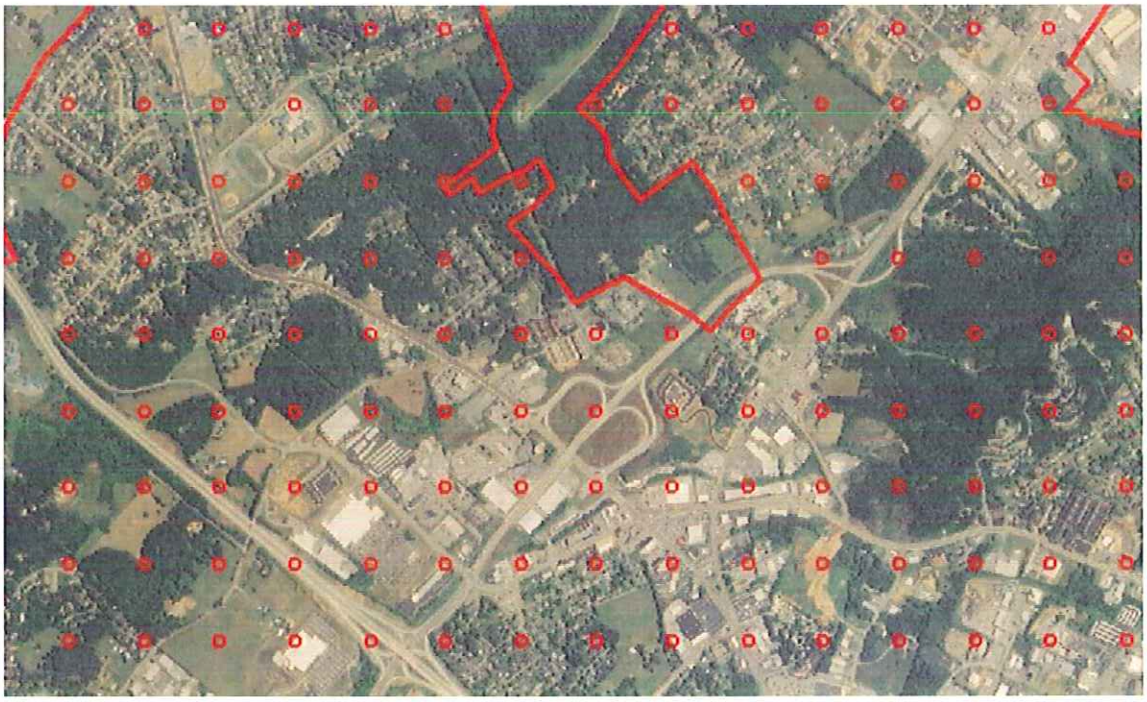
City of Knoxville, TN

Tree Canopy Report

March, 2014



Presented to

Knoxville Urban Forestry Program

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Urban Forest
Resource Management

Canopy Cover Analysis for City of Knoxville
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Background

The so ware used for this analysis is fGIS, which the Division accessed from the web. It is based on an early version of ArcView and is modi ed for forestry uses.

Aerial photos were taken by ights in 1997 and 2010. Both years' photos were taken at one meter resolu on. The 1997 photo was black and white and was taken in the winter (leaf o) and the 2010 photo was color and taken in the summer (leaf on).

Tiger census les are typically the source of municipal boundaries for this type of study and come from the 2000 census. In the case of the City of Knoxville, however, the city boundary maps, both for 1997 and 2010, were furnished as shape les by the GIS sec on for the city. These les were then overlaid onto the aerial maps, allowing for accurate and mely area assessments. Addi onally, the city was divided into six city council districts in order to allow speci c analysis by areas of the town.

Aerial photos generally indicate land use pa ern changes and the city boundary maps generally indicate land mass changes (annexa ons). Knoxville was heavily involved in " nger annexa on" but much of it was prior to the 1997 map and therefore had li le e ect on the overall city boundaries in this study. There was some di erence between the 1997 and 2010 boundaries and that di erence amounted to approximately 7 square miles between the two studies. Since the city council district boundaries furnished by the City were on the 2010 city boundary, the 1997 city council boundaries were considered to be iden cal (for equal comparison) and overlaid over the 1997 city boundary shape le. Adjustments to the boundaries could then be made to the individual city council boundaries so that the 1997 data re ected the true 1997 boundaries. Again, according to the furnished shape les, the City of Knoxville grew in size by almost 7 square miles over the 13 year period of this study.

The 2010 canopy cover analysis predicted the area within Knoxville to be 65,958.4 acres or 103.06 square miles. For comparison, the projected size of the 1997 canopy cover had the city at 96.11 square miles. Interes ngly, the 2005 UT MTAS lis ng (based on 200 ger le data?) had Knoxville at 77.2 square miles.

Method

A dot grid was generated at a 900 X 900 foot spacing and applied over each of the aerial photos, and each dot was then examined to determine if there was canopy or not. This allows

the same dot over each of the aerial maps to be compared equally, that is, each dot on both the 1997 and the 2010 maps is posi oned over exactly the same point on the land surface. Land use changes over the period then become more dis nct and conspicuous. Photos were analyzed at approximately 1:500 scale. This seemed to be the largest scale feasible to maintain adequate resolu on. Scales above this point became pixilated and accurate readings could not be made.

Addi onally, on the request of Kasey Krause, City Forester for Knoxville, an es mate of the amount of impervious surfaces and water surfaces was also determined. The remaining land was then judged as "other pervious surfaces" which normally appears as grass, dirt, or small shrub areas. For the purposes of this study, "other pervious surfaces" contributes to water percola on and helps mi gate water runo but is not considered tree canopy. However, those surfaces do bene t the community in mi ga ng heat radia on and in some instances other "green" bene ts are realized.

Each grid dot was a small circle, and the "reading" of whether the point contained canopy, impervious surfaces, water, or "other pervious surfaces" was accomplished by looking within the circle.

Overall City Data

1997 Photo & Results on the 1997 boundary

The 1997 photo analysis was done on a 900 X 900 . grid. The overall city results were:

Canopy %	Impervious Surface %	Other Pervious Surface %	Water %	Standard Error
39.9 %	**27.1 %**	**28.1 %**	**5%**	**0.9%**

2010 Photo & Results on the 2010 boundary

The 2010 photo analysis was also done on a 900 X 900 . grid for comparison. The overall city results were:

Canopy %	Impervious Surface %	Other Pervious Surface %	Water %	Standard Error
39.5 %	**32.6 %**	**22.9 %**	**5%**	**0.8%**

Discussion & Conclusions

The City of Knoxville has approximately 26,064 acres of tree canopy. The city also has 16,034 acres of other green space or bare soil. There are also 3,200 acres of water within its boundaries.

According to this study, the City of Knoxville has lost almost no canopy cover over the 13 years of the study. However, the city has also annexed 7 square miles more land, no ceably including more forests and rural areas containing canopy. Similar studies in other towns across the state have revealed a normal decrease in canopy cover over the period due to urban sprawl, annexa ons, and development (except where annexa ons included signi cant forested areas). Such appeared to be the case in this study.

The study also revealed that Knoxville *almost* meets the American Forests' previous desired goal of 40% urban tree canopy cover overall. Canopy cover has posi ve implica ons for many urban quality issues, including reducing storm water runo , air pollu on abatement, heat island e ect improvement, carbon storage increase and others. No speci c economic gures, based on canopy cover, can be provided with this limited study.

Addi onally, the study indicates that the city gained 5.5% in impervious surfaces overall in the 13 year period of study. This factor alone is alarming because an increase in impervious surfaces has a direct correla on to the ability of the city to handle storm water, especially during unusual rain incidents. What is more signi cant in this situa on for Knoxville is the loss of other pervious surfaces (grass, dirt and small shrubby areas) in conjunc on with the increase in impervious surfaces. Thus, the study indicates that the city's natural environment is not able to handle storm water runo nearly as e cient as it did in 1997, even with its resultant increase in land size.

Council Districts

The City of Knoxville is divided into six dis nct council districts and each district was studied separately over the 13 year period. This allows a comparison between sec ons of the city and helps pinpoint signi cant land use changes over the years. By studying each individual district separately, the city planning process can be tailored toward district circumstances. The results can be found in Table 1:

Table 1: Canopy Cover Study by Council Districts

Area	1997 Canopy %	2010 Canopy %	Percent Change	1997 Imp. Sur.	2010 Imp. Sur.	Percent Change
District 1	45.5%	51%	+ 5.5%	20.8%	28%	+ 7.2%
District 2	34.8%	35%		25.4%	33.8%	+ 8.4%
District 3	44.8%	39.4%	- 5.4%	28.7%	34%	+ 5.3%
District 4	44.3%	42%	- 2.3%	20.8%	28%	+ 7.2%
District 5	39%	35%	- 4.0%	35.6%	35.4%	
District 6	31.4%	34%	+ 2.6%	35.2%	38%	+ 2.8%

Table 2: Changes in Other Pervious Surfaces and Percentage of Water per Council District

Area	Other Pervious Surfaces 1997	2010	Percent Change	Water Percent
District 1	28.5%	15.3%	- 13.2%	5.6%
District 2	25.3%	17 %	- 8.3%	14 %
District 3	26.6%	26.6%	0%	0%
District 4	32.8%	28%	- 4.8%	2%
District 5	25%	29.5%	+ 4.5%	0%
District 6	29.9%	24.3%	- 5.6%	3.5%

Table 3: Council District Sizes & Changes

	1997 Size	2010 Size	Change
District 1	15.2 Sq. Mi.	16.7 Sq. Mi.	+ 1.5 Sq. Mi.
District 2	21.5 Sq. Mi.	24.0 Sq. Mi.	+ 2.5 Sq. Mi.
District 3	15.3 Sq. Mi.	15.7 Sq. Mi.	+ 0.4 Sq. Mi.
District 4	17.9 Sq. Mi.	19.4 Sq. Mi.	+ 1.5 Sq. Mi.
District 5	12.4 Sq. Mi.	13.28 Sq. Mi.	+ 0.9 Sq. Mi.
District 6	13.8 Sq. Mi.	14.0 Sq. Mi.	+ 0.2 Sq. Mi.

Conclusions

District 1 gained the most canopy cover in the study (5.5%) but also gained the second most impervious surfaces (7.2%). The district also gained the second most land mass during the study. A signi cant por on of the district was included in the Tennessee River (5.6%) and other pervious surfaces reduced by 13.2% over the study period. It was noted that some of the abandoned farm land in this district reforested slightly during the period, which helped explain the gain in canopy cover and the loss of other pervious surfaces. However, an increase in housing and commercial areas accounted for some of the impervious surface increase.

District 2 was able to maintain its canopy cover despite gaining the most in land mass (2.5 Square Miles), but also had the most gain in impervious surfaces (8.4%). It was noted during the study that much of the gain in land size was found in subdivisions and commercial areas, which no doubt contributes to this increase in impervious surfaces. It also lost 8.3% of its other pervious surfaces, with much of that also converted to impervious surfaces. This district has the largest amount of water areas (14%), with almost all of that within the Tennessee River.

District 3 did not change signi cantly in land size but lost signi cant canopy (5.4%) and gained impervious surfaces (5.3%). Other pervious surfaces stayed the same and water accounted for no area.

District 4 lost canopy, lost other pervious surfaces and gained even more impervious surfaces, while also gaining land size. Water accounted for only 2 % of the land mass.

District 5 lost canopy with its gain in land mass but was able to avoid increases in impervious surfaces. Interes ngly enough, it also increased its other pervious surfaces by 4.5%.

District 6 gained the least in land size, was able to increase canopy (2.6%) but also gained almost the same amount in impervious surfaces (2.8%), while losing 5.6% of its other pervious surfaces. It also has 3.5% of its land mass in the Tennessee River.

Addi onal Notes & Cau ons

The 1997 photo was much more di cult to analyze due to it being a black & white photo taken during leaf o . Determining impervious surfaces on a black & white photo is also much more di cult, par cularly when pixila on is a concern. Several of the 1997 development sites appeared to be in the early phases and much of the surface area appeared to be disturbed dirt rather than asphalt or concrete at that me. In these instances, a best guess as to that surface was recorded. The possibility of error in those cases is greater than desired.

Comparisons between this study and the 2002 Urban Ecosystem Analysis for Knox County (conducted by American Forests) are di cult and realis cally impossible. For one, the 2002 study involved the en re county and 40 sub watersheds, while this study focused en rely upon the City of Knoxville. For another, the 2002 study analyzed canopy data from 1989 to 1999, while this study analyzed canopy data over a 13 year period from 1997 to a more recent period, 2010.

Limita ons

The Division of Forestry is s ll learning to conduct canopy cover analysis for ci es and towns using this method. The sta thinks the methodology is sound and the sta s cs are valid, but there may be a problem with one or both that is unknown at this me. In previous similar studies with Tennessee towns, the canopy cover study has been able to accurately delineate problem areas for stormwater concerns.

What is next for Knoxville?

The urban forestry program of the city could:

1. Increase tree canopy in most of the council districts, focusing on development situa ons with a priority in commercial areas. State urban forestry tree plan ng grants are currently available to assist with this.
2. Consider incorpora ng pervious concrete into urban street plan ngs, par cularly in areas where the amount of impervious surfaces has increased (all council districts except for district 5).
3. Incorporate into its policies on land use planning certain ac ons that reduce impervious surfaces (i.e. more green space, wider plan ng mediums, etc.).
4. Improve its urban and community forest management and planning and incorporate those prac ces and programs into its planning and zoning standards.